Tennessee Science Curriculum Framework

Conceptual Physics

Course Description

Conceptual Physics is a laboratory science course that examines the interactions between matter and energy. Students explore physics concepts through an inquiry approach.

Conceptual Physics students will study:

- Inquiry
- Mathematics
- Technology and Engineering
- Mechanics
- Thermodynamics
- Waves and Optics
- Electricity and Magnetism
- Nuclear Science

Embedded Inquiry

Conceptual Strand

Understandings about scientific inquiry and the ability to conduct inquiry are essential for living in the 21st century.

Guiding Question

What tools, skills, knowledge, and dispositions are needed to conduct scientific inquiry?

Course Level Expectations

CLE 3200.Inq.1 Recognize that science is a progressive endeavor that reevaluates and extends what is already accepted.

CLE 3200.Inq.2 Design and conduct scientific investigations to explore new phenomena, verify previous results, test how well a theory predicts, and compare opposing theories.

CLE 3200.Inq.3 Use appropriate tools and technology to collect precise and accurate data.

CLE 3200.Inq.4 Apply qualitative and quantitative measures to analyze data and draw conclusions that are free of bias.

CLE 3200.Inq.5 Compare experimental evidence and conclusions with those drawn by others about the same testable question.

CLE 3200.Inq.6 Communicate and defend scientific findings.

Checks for Understanding (Formative/Summative Assessment)

- ✓ **3200.Inq.1** Develop a testable question for a scientific investigation.
- ✓ **3200.Inq.2** Develop an experimental design for testing a hypothesis.
- ✓ **3200.Inq.3** Select appropriate independent, dependent, or controlled variables for an experiment.
- ✓ **3200.Inq.4** Perform an experiment to test a prediction.
- ✓ **3200.Inq.5** Gather, organize, and transform data from an experiment.
- ✓ **3200.Inq.6** Analyze and interpret the results of an experiment.
- ✓ **3200.Inq.7** Apply knowledge and data-interpretation skills to support a conclusion.
- ✓ **3200.Inq.8** State a conclusion in terms of the relationship between two or more variables.
- ✓ **3200.Inq.9** Compare the results of an experiment with what is already known about the topic under investigation.
- ✓ **3200.Inq.10** Suggest alternative explanations for the same set of observations.
- ✓ **3200.Inq.11** Analyze experimental results and identify possible sources of experimental error.
- ✓ **3200.Inq.12** Formulate and revise scientific explanations and models using logic and evidence.
- ✓ **3200.Inq.13** Identify a question that guides a scientific investigation.
- ✓ **3200.Inq.14** Transform data into a table, graph, or diagram.
- ✓ **3200.Inq.15** Analyze data from a table, graph, or diagram.
- ✓ **3200.Inq.16** Recognize and analyze alternative explanations and models.
- ✓ **3200.Inq.17** Determine whether data supports or contradicts a simple hypothesis or conclusion.

Embedded Technology and Engineering

Conceptual Strand

Society benefits when engineers apply scientific discoveries to design materials and processes that develop into enabling technologies.

Guiding Question

How do science concepts, engineering skills, and applications of technology improve the quality of life?

Course Level Expectations

CLE 3200.T/E.1 Explore the impact of technology on social, political, and economic systems.

CLE 3200.T/E.2 Differentiate among elements of the engineering design cycle: design constraints, model building, testing, evaluating, modifying, and retesting.

CLE 3200.T/E.3 Explain the relationship between the properties of a material and the use of the material in the application of a technology.

CLE 3200.T/E.4 Describe the dynamic interplay among science, technology, and engineering within living, earth-space, and physical systems.

Checks for Understanding (Formative/Summative Assessment)

- ✓**3200.T/E.1** Select appropriate tools to conduct a scientific inquiry.
- ✓**3200.T/E.2** Apply the engineering design process to construct a prototype that meets developmentally appropriate specifications.
- ✓**3200.T/E.3** Explore how the unintended consequences of new technologies can impact human and non-human communities.
- ✓**3200.T/E.4** Present research on current engineering technologies that contribute to improvements in our daily lives.
- ✓**3200.T/E.5** Design a series of multi-view drawings that can be used by other students to construct an adaptive design and test its effectiveness.

Embedded Mathematics

Conceptual Strand

Physics applies mathematics to investigate questions, solve problems, and communicate findings.

Guiding Question

What mathematical skills and understandings are needed to successfully investigate conceptual physics?

Course Level Expectations

CLE 3200.Math.1 Understand the mathematical principles that underlie the science of physics.

CLE 3200.Math.2 Utilize appropriate mathematical equations and processes to solve basic physics problems.

Checks for Understanding (Formative/Summative Assessment)

- ✓**3200.Math.1** Use a variety of notations appropriately (e.g., exponential, functional, square root).
- ✓**3200.Math.2** Select and apply an appropriate method for computing with real numbers, and evaluate the reasonableness of results.
- ✓**3200.Math.3** Apply and interpret rates of change from graphical and numerical data.
- ✓**3200.Math.4** Analyze graphs to describe the behavior of functions.
- ✓**3200.Math.5** Interpret results of algebraic procedures.
- ✓**3200.Math.6** Model real-world phenomena using functions and graphs.
- ✓**3200.Math.7** Articulate and apply algebraic properties in symbolic manipulation.
- ✓**3200.Math.8** Apply and communicate measurement concepts and relationships in algebraic and geometric problem-solving situations.
- ✓**3200.Math.9** Make decisions about units, scales, and measurement tools that are appropriate for problem situations involving measurement.

- ✓**3200.Math.10** Collect, represent, and describe linear and nonlinear data sets developed from the real world.
- ✓**3200.Math.11** Make predictions from a linear data set using a line of best fit.
- ✓**3200.Math.12**1nterpret a set of data using the appropriate measure of central tendency.
- ✓**3200.Math.13** Choose, construct, and analyze appropriate graphical representations for a data set.
- ✓**3200.Math.14** Use real numbers to represent real-world applications (e.g., slope, rate of change, probability, and proportionality).
- ✓**3200.Math.15** Apply right triangle relationships including the Pythagorean Theorem and the distance formula.
- ✓**3200.Math.16** Use concepts of length, area, and volume to estimate and solve real-world problems.
- ✓**3200.Math.17** Demonstrate an understanding of rates and other derived and indirect measurements (e.g., velocity, miles per hour, revolutions per minute, cost per unit).

Standard 1 – Mechanics

Conceptual Strand 1

The laws and properties of mechanics provide the foundations of 3200 physics.

Guiding Question 1

How do the laws and properties of mechanics govern the basic understanding of physics?

Course Level Expectations

CLE 3200.1.1 Investigate fundamental physical quantities of mass and time.
CLE 3200.1.2 Analyze and apply Newton's three laws of motion.
CLE 3200.1.3 Differentiate among work, energy, and power.
CLE 3200.1.4 Investigate kinematics and dynamics.

Checks for Understanding (Formative/Summative Assessment)

- ✓ **3200.1.1** Investigate, measure, and calculate position, displacement, velocity and acceleration.
- ✓ **3200.1.2** Analyze vector diagrams.
- ✓ **3200.1.3** Explore characteristics of rectilinear motion and create distance-time graphs and velocity-time graphs.
- ✓ **3200.1.4** Investigate the characteristics of centripetal motion and centripetal acceleration.
- ✓ **3200.1.5** Evaluate the dynamics of systems in motion and collisions including friction, gravity, impulse and momentum, change in momentum and conservation of momentum.
- ✓ **3200.1.6** Investigate projectile motion.
- ✓ **3200.1.7** Distinguish between mass and weight using SI units.
- ✓ **3200.1.8** Measure and calculate mechanical advantage of mechanical devices.

✓ **3200.1.9** Relate time to the independent variable of most experiments.
✓ **3200.1.10** Relate inertia, fore, or action-reaction forces to Newton's three laws of motion and distinguish among the three laws in various scenarios.
✓ **3200.1.11** Compare, contrast, and apply the characteristic properties of scalar and vector quantities.
✓ **3200.1.12** Investigate the definitions of force, work, power, kinetic energy and potential energy.
✓ **3200.1.13** Analyze the characteristics of energy, and conservation of energy including friction, and gravitational potential energy.

Standard 2 – Thermodynamics

Conceptual Strand 2

The principles and laws of thermodynamics are essential for understanding the concept of energy.

Guiding Question 2

How do the laws of thermodynamics relate to understanding the conservation of energy?

Course Level Expectations

CLE 3200.2.1 Develop an understanding of the relationships among temperature, heat, and internal energy.
CLE 3200.2.2 Compare Fahrenheit, Celsius, and Kelvin temperature scales.
CLE 3200.2.3 Investigate exchanges in internal energy.

Checks for Understanding (Formative/Summative Assessment)

✓**3200.2.1** Investigate the relationship between temperature and kinetic energy.
✓**3200.2.2** Distinguish among internal energy, temperature, and heat.
✓**3200.2.3** Investigate changes in heat using calorimetry.
✓**3200.2.4** Investigate energy changes associated with heats of fusion and vaporization.
✓**3200.2.5** Explore thermal expansion and contraction.
✓**3200.2.6** Apply the Second Law of Thermodynamics to the Carnot engine.
✓**3200.2.7** Apply the Laws of Thermodynamics to atmospheric and climatic changes.
✓**3200.2.8** Recognize that absolute zero is the absence of molecular kinetic energy.
✓**3200.2.9** Relate the First Law of Thermodynamics as an application of the Law of Conservation of Energy to heat transfer through conduction, convection, and radiation.

Standard 3 – Waves and Optics

Conceptual Strand 3

Understanding sound and light is accomplished by investigating wave behavior.

Guiding Question 3

How does the wave model explain the phenomena of sound and light?

Course Level Expectations

CLE 3200.3.1 Explore conditions associated with simple harmonic motion.
CLE 3200.3.2 Investigate Hooke's law.
CLE 3200.3.3 Understand wave mechanics.
CLE 3200.3.4 Examine the Doppler Effect.
CLE 3200.3.5 Explore the characteristics and properties of sound.
CLE 3200.3.6 Describe the characteristics of the electromagnetic spectrum.
CLE 3200.3.7 Investigate the interaction of light waves.
CLE 3200.3.8 Explore the optics of mirrors and lenses.
CLE 3200.3.9 Investigate the phenomenon of color.

Checks for Understanding (Formative/Summative Assessment)

✓ **3200.3.1** Explore Hooke's Law.
✓ **3200.3.2** Investigate simple harmonic motion.
✓ **3200.3.3** Investigate and analyze wavelength, frequency and amplitude of longitudinal and transverse waves.
✓ **3200.3.4** Compare mechanical and electromagnetic waves.
✓ **3200.3.5** Investigate reflection, refraction, diffraction, and interference of sound waves.
✓ **3200.3.6** Demonstrate the Doppler Effect.
✓ **3200.3.7** Determine the speed of sound experimentally and describe how various materials and temperatures affect wave transmission.
✓ **3200.3.8** Measure spring constants.
✓ **3200.3.9** Compare wave characteristics to natural auditory phenomena.
✓ **3200.3.10** Explore properties of the electromagnetic spectrum.
✓ **3200.3.11** Examine properties of light waves.
✓ **3200.3.12** Investigate reflection, refraction, diffraction, and interference of light waves.
✓ **3200.3.13** Investigate the polarization of plane and curved mirrors.
✓ **3200.3.14** Solve problems related to Snell's laws
✓ **3200.3.15** Explore the additive and subtractive properties associated with color formation.
✓ **3200.3.16** Use ray tracings to solve optics of mirrors and lenses problems.
✓ **3200.3.17** Investigate optical phenomena (e.g., mirage, optical illusions, and dichromatic lens effect).
✓ **3200.3.18** Distinguish between coherent and incoherent light.
✓ **3200.3.19** Describe how a laser is produced.

Standard 4 – Electricity and Magnetism

Conceptual Strand 4

Various tools and equipment can be used to investigate the interplay between magnetic fields and the generation of electricity.

Guiding Question 4

What force and energy concepts are needed to explain magnetism and electricity?

Course Level Expectations

CLE 3200.4.1 Distinguish among electric forces, electric charges, and electric fields.
CLE 3200.4.2 Explore static and current electricity.
CLE 3200.4.3 Investigate Ohm's law.
CLE 3200.4.4 Compare and contrast series and parallel circuits.
CLE 3200.4.5 Analyze schematic diagrams.
CLE 3200.4.6 Investigate magnetic poles, magnetic fields, and electromagnetic induction.

Checks for Understanding (Formative/Summative Assessment)

✓ **3200.4.1** Measure voltage, current, and resistance.
✓ **3200.4.2** Draw electric field lines, given a scenario of charged particles.
✓ **3200.4.3** Draw and explain series and parallel circuits.
✓ **3200.4.4** Identify components of series and parallel circuits and solve problems related to voltage, current, and resistance.
✓ **3200.4.5** Build series and parallel circuits and demonstrate how they function.
✓ **3200.4.6** Demonstrate and explain electromagnetic induction.
✓ **3200.4.7** Sketch magnetic field lines around a bar magnet.
✓ **3200.4.8** Create a simple electromagnet.

Standard 5 – Nuclear Science

Conceptual Strand 5

A deeper understanding of particle physics is accomplished by investigating the properties of nuclear science.

Guiding Question 5

What particle physics concepts explain nuclear science?

Course Level Expectations

CLE 3200.5.1 Investigate the properties and structure of the atom.
CLE 3200.5.2 Explore the dynamics of the nucleus: radioactivity, nuclear decay, radiocarbon/uranium dating, and half-life.
CLE 3200.5.3 Compare and contrast nuclear fission and nuclear fusion.
CLE 3200.5.4 Investigate quantum theory.

Checks for Understanding (Formative/Summative Assessment)

- ✓ **3200.5.1** Identify the parts of an atom.
- ✓ **3200.5.2** Describe the properties and location of subatomic particles.
- ✓ **3200.5.3** Explain how particles behave like waves.
- ✓ **3200.5.4** Describe three forms of radioactivity in terms of changes in atomic number or mass number.
- ✓ **3200.5.5** Investigate the concept of half-life.
- ✓ **3200.5.6** Write balanced equations for the three forms of radioactive decay.
- ✓ **3200.5.7** Explain carbon-14 or uranium dating methods.
- ✓ **3200.5.8** Investigate the history of nuclear science.
- ✓ **3200.5.9** Distinguish between nuclear fission and nuclear fusion in terms of transmutation.